Accordingly, entry of these amendments before examination on the merits is hereby requested.

Respectfully submitted,

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SPECIFICATION

TITLE

PRINTER DEVICES WORKING WITH AT LEAST THREE BRIGHTNESS LEVELS AS WELL AS METHODS FOR THE DETERMINATION OF PRINTING PARAMETERS TO BE IMPLEMENTED THEREWITH

BACKGROUND OF THE INVENTION

Field of the Invention

The present ~~The~~ invention is directed to a method for the operation of an electrophotographic printer or copier device as well as to printer devices for the implementation of the ~~methods [sic].~~ **method.**

~~US Letters Patent~~ Description of the Related Art

US Patent No. 5,767,888 discloses a method wherein an optical character generator generates a charge image composed of a plurality of charge regions on a photoconductor with at least one light source. The size and shape of the charge regions is influenced by the illumination energy emitted by the light source. Light encoding data are generated from the print data of a print image, ~~said~~ **the** light encoding data respectively containing one of at least three different light encoding values and then being employed for the drive of the light source.

In contrast to traditional bi-level character generators, character generators driven with more than two light encoding values are referred to as multi-level character generators and contain, for example, an LED line or a multi-plane laser. Although there are more than two light encoding values given multi-level character

generators, there are ultimately only printed or non-printed surfaces. Compared to bi-level character generators, however, multi-level character generators offer the possibility of designationally defining the size and shape of the charge regions in order to produce the impression of different gray scale values for someone who

5   views the developed charge image. Such a multi-level character generator is disclosed by US ~~Letters~~ Patent **No.** 5,767,888, which is part of the disclosure of this application **and is incorporated herein by reference**.

What is disadvantageous about the known printing with multi-level character generators is that the print quality ~~sinks~~ **declines** given changing printing conditions.

10   For example, these printing conditions include the age of the photoconductor and the quality of the toner or, respectively, developer. Methods with which print images having good quality can be printed even given modified printing conditions are employed for printers with bi-level character generators, see, for example, the methods set forth in **published International Patent Application** WO 97/37285.

15   However, the quality that is still adequate for printer devices with **a** bi-level character generator does not always meet the significantly higher demands and possibilities that derive given employment of a multi-level character generator.

Further methods for the operation of an electrographic printer or copier device are known from US **Patent No.** 5,694,223, **Published International Patent**

20   **Application** WO 97/37285, **German Patent Document** DE 43 43 274 A1, US **Patent No.** 5,734,948 and US **Patent No.** 5,241,347.

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SUMMARY OF THE INVENTION

An object of the **present** invention is to ~~specify~~ **provide** a method for the operation of an electrophotographic printer or, respectively, copier device with **a** multi-level character generator with which print images having high print quality can also be printed given changing printing conditions. Further, printer devices with which such methods can be implemented are to be specified.

This ~~object is achieved by a method having the method steps indicated in patent claim 1. Developments are indicated in the subclaims.~~

~~The~~ **and other objects and advantages of the invention are achieved by a method for the operation of an electrophotographic printer or copier device, whereby an optical character generator illuminates a photoconductor with at least one light source, light encoding data is generated from print data of a print image, the light encoding data respectively contain one of at least three different light encoding values that are allocated to different reference illumination energy values, the reference illumination energy values are employed for printing when the photoconductor has a predetermined reference discharge characteristic indicating the relationship of illumination energy and potential on the photoconductor, a discharge characteristic indicating the relationship of illumination energy and potential on the photoconductor is taken into consideration in a balancing event in the definition of corrected illumination energies, in a balancing event, the**

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corrected illumination energy to be emitted by the character generator is respectively determined for each light encoding value dependent on a deviation of the discharge characteristic from the reference discharge characteristic given a potential that belongs to the reference illumination

5   energy employed according to the reference discharge characteristic given the respective light encoding value, whereby the value of the respective, corrected illumination energy deviates all the more from the value of the reference illumination energy belonging to the same light encoding value the greater the deviation of the characteristics from one another is given the potential

10   belonging to the respective light encoding value according to the reference discharge characteristic.

The method in one embodiment provides that respectively one correction parameter is determined for each light encoding value, the corrected illumination energy values for the appertaining light encoding

15   values being calculated therewith. In particular, the discharge characteristic is acquired completely or in points, a photoconductor potential is prescribed for each light encoding value, and in that the corrected illumination energy is respectively determined from the discharge characteristic for a light encoding value for the predetermined potential. Specifically, the discharge

20   characteristic is determined completely or in points,

a photoconductor potential is prescribed for at least one light encoding value, a corrected illumination energy is determined from the discharge characteristic for the predetermined potential, and in that the corrected illumination energies for the other light encoding values are determined by estimates. In a specific embodiment, a mathematical model is employed for the discharge characteristic of the photoconductor. For example, the following model is employed:

$$V_D(K,T,H) = (V_C - V_{LIM}) \cdot exp(-K \cdot T \cdot H) + V_{LIM}, \tag{1}$$

whereby

V_C is the charge potential of the photoconductor in volts,

V_D is the discharge potential of the photoconductor in volts,

V_{LIM} is the lowest obtainable discharge potential in volts,

H is the illumination energy in $\mu Ws/cm^2$,

T is the currently acquired temperature of the photoconductor in °C,

K is the photoconductor class in $cm^2 / (\mu Ws °C)$, and

exp is the exponential function.

In the method, the discharge characteristic is taken into consideration in at least one regulating or control event wherein the corrected illumination energy for a light encoding value is determined such that a potential predetermined for the light encoding value or, respectively, a potential lying close to this potential arises on the photoconductor given an illumination

according to the light encoding value and appertaining, corrected illumination energy. A development characteristic indicating the current relationship of potential on the photoconductor and toner deposit may be taken into consideration in the determination of the corrected illumination energies and/or of further printing parameters.

In a preferred development, at least one toner mark is applied onto the photoconductor and/or onto a carrier material upon employment of the corrected illumination energies; the toner deposit in the region of the toner mark is acquired, preferably with an optical or capacitative measuring sensor; and at least one further printing parameter that influences the development process and/or the illumination process is prescribed dependent on the toner deposit. As a further development, a plurality of toner marks with different rastering are applied; and the toner deposits in the region of the toner marks are acquired. The sensor acquires the toner deposit in the region of the toner mark in integrating fashion.

Only a section of the illumination characteristic and/or of the development characteristic is taken into consideration according to one embodiment. The balancing event is automatically implemented, preferably after a printer or, respectively, copier device is turned on and/or after longer printing pauses and/or after longer printer operation and/or on demand of an operator. A potential value that should occur on the photoconductor given

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illumination according to the respective light encoding value is prescribed for each light encoding value; and the illumination energy value determined by the discharge characteristic given the potential predetermined for the light encoding value is employed as a corrected illumination energy for a light

5   encoding value. The reference illumination energy value prescribed for the appertaining light encoding value is involved for the determination of a corrected illumination value.

The present invention also provides an electrophotographic printer or, respectively, copier device, with an optical character generator that

10   illuminates a photoconductor with at least one light source, a print data unit that generates light encoding data with at least three different light encoding values from the print data of a print image, whereby the light encoding values are allocated to different reference illumination energies, and whereby the reference illumination energy values are employed for printing when the

15   photoconductor has a prescribed reference discharge characteristic indicating the relationship of illumination energy and potential on the photoconductor, and with a drive unit for driving the light source dependent on the light encoding data, characterized by a correction unit in which a discharge characteristic indicating the relationship between illumination energy and

20   potential on the photoconductor is taken into consideration in the determination of corrected illumination energies; and the correction unit

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determines the corrected illumination energy such for each light encoding value that the value of the respective, corrected illumination energy deviates all the more from the value of the reference illumination energy belonging to the same light encoding value the greater the deviation of the characteristic

5 **from the reference discharge characteristic is given a potential that belongs to the reference illumination energy employed for the respective light encoding value according to the reference discharge characteristic,**

and in that the drive unit also drives the light source dependent on the corrected illumination energies.

10 **The present** invention proceeds from the consideration that a multi-level character generator enables a high printing quality due to the plurality of different illumination energy values. However, the different illumination energy values can also be utilized for influencing the printing event in a way different from previously **performed**. In the inventive method, illumination energy values that are corrected in

15 a balancing procedure and that respectively belong to a light encoding value are therefore used in the inventive method. By employing the corrected illumination energy values, new degrees of freedom for influencing the printing event derive given the inventive method.

The inventive method also proceeds from the perception that a print

20 characteristic for the overall print event indicating the relationship of light encoding values and toner deposit is essentially defined by a photoconductor discharge

characteristic of the photoconductor discharge process and by a development

characteristic for the electrophotographic development process. The discharge

characteristic indicates the relationship of potential on the photoconductor and toner

deposit. Examples of these characteristics are explained in the aforementioned US

5   Letters Patent No. 5,767,888. In addition to the current discharge characteristic, the

current development characteristic for a predetermined printing characteristic should

be taken into consideration by selecting suitable, corrected illumination energy

values.

The corrected illumination energy values are defined such in the inventive

10   method that the printing characteristic has a predetermined curve even given

deviations of the current photoconductor discharge characteristic and a reference

photoconductor discharge characteristic. For example, the reference characteristics

are established shortly after manufacture of the printed. The printing characteristic

is prescribed such that a high-quality print image derives.

15   In one development, the discharge characteristic and/or the developing

characteristic are influenced by the variation of printing parameters that the

predetermined curve of the printing characteristic is also achieved when additional

conditions limit the free selection of the corrected illumination energy values.

When it is essentially only the discharge characteristic of the photoconductor

20   that changes during the service life of the printer or, respectively, copier, then it

suffices to give priority consideration to the influence thereof on the printing event.

In the inventive method, the discharge characteristic present at the point in time of

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printing is taken into consideration in order to determine the corrected illumination

energies for the light encoding values such that the influence of changes of the

discharge characteristic on the printing event are compensated.

In developments of the inventive ~~methods~~ **method**, correction parameters are

5   determined that have values deviating from one another due to the non-linear

discharge characteristic and that are a criterion for the deviation of the current

discharge characteristic from a rated discharge characteristic of the photoconductor

at a potential that belongs to the reference illumination energy value allocated to the

respective light encoding value according to the rate discharge characteristic. The

10   corrected illumination energies are then calculated, for example by multiplication of

the reference illumination energy values by the respective correction parameter.

In one development of the ~~methods~~ **method** according to the first or second

aspect of the invention, the discharge characteristic is acquired completely or at

points. This ensues by measurements at the photoconductor. In addition to the

15   temperature of the photoconductor, for example, a discharge potential that occurs

given a predetermined illumination energy is acquired. Subsequently, parameters

can be determined in a characteristics equation that approximately reproduces the

curve of the characteristic of the photoconductor present at the printing time. On the

other hand, however, a number of points of the illumination characteristic can be

20   acquired between which the characteristic is interpolated. In this development, a

photoconductor potential that should arise on the photoconductor given the

respective light encoding value is prescribed for each light encoding value. A

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corrected illumination energy is determined for each light encoding value with the assistance of the predetermined potential and the discharge characteristic.

In another development, the discharge characteristic is likewise determined. However, photoconductor potentials are not prescribed for all light encoding values but, for example, for only one light encoding value. The corrected illumination energy or, respectively, correction factor can then be determined from the illumination characteristic for only this light encoding value. The other corrected illumination energy values or, respectively, correction factors for the other light encoding values are then determined by approximations that, for example, are already stored in tables. This method can be implemented fast and simply.

In another development of the inventive methods, ~~th~~ **the** discharge characteristic is taken into consideration in at least one regulating or control event. The respective correction parameter is determined such that a potential predetermined for the light encoding value or, respectively, a potential lying close to this potential arises on the photoconductor given an illumination according to the light encoding value and appertaining correction parameter. For example, a method with a PID regulator (proportional, integral, differentiating regulator) is employed as regulating method. No approximation for the characteristic need be prescribed given employment of a regulating or, respectively, control method.

In a development of the method according to the second aspect, a development characteristic is likewise taken into consideration in the determination of the corrected illumination energy values or, respectively, correction parameters

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and/or further printing parameters. As a result of this measure, the conditions of the development process are taken into consideration in the determination of the correction parameters in addition to the current conditions of the illumination or, respectively, discharge process.

5   In a development of the inventive methods, the development characteristic is determined upon employment of the corrected illumination energies. Toner marks, **which are** preferably raster toner marks, are employed for the determination of the development characteristic. The employment of raster toner marks, wherein a toner region has **a** checkerboard-like or stripe-like toner-free or, respectively,

10   toner-covered regions, assures that the presentation of image details is also taken into consideration.

The balancing event is automatically implemented, preferably after a printer or, respectively, copier device is turned on, after longer printing pauses, after a longer printing operation and/or on demand of an operator. It is to be assumed that

15   the printing conditions have changed precisely at these points in time.

The invention is also directed to printer or, respectively, copier devices with which the inventive methods or, respectively, their developments can be implemented. The aforementioned technical effects thus also apply to the printer devices.

20   **BRIEF DESCRIPTION OF THE DRAWINGS**

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Exemplary embodiments of the invention are explained below on the basis of

the attached drawings. Shown therein are:

Figure 1 **is** a schematic illustration of a printing event;

Figure 2 **is a graph showing** a potential/illumination energy diagram;

Figure 3 **is a block diagram of** a conversion and correction unit;

Figure 4 **is a listing of** equations for the approximation of a photoconductor

characteristic;

Figure 5 **is a graph of** another potential/illumination energy diagram;~~and~~.

Figure 6 **is** a four-quadrant diagram with characteristics of the printing event.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a schematic illustration of a printing event as well as the

information flow when printing in an electrophotographic printer or copier device 10.

Print data 14 that define a print image, for example according to the known

postscript format, are input in the printer device 10 via an electronic interface 12. A

print data unit 16 contains a microprocessor MP that processes a conversion

program stored in a memory 18. The print data unit 16 generates light encoding

data 20 for the individual LEDs (light-emitting diode) of a character generator 22

from the print data 14. The light encoding datum for an LED is stored in two bits of a

data word. There are thus four light encoding values LCW with the values 0, 1, 2

and 3. No illumination is carried out given the light encoding value LCW=0. Given

the light encoding value LCW=1, illumination is carried out such that the respective

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LED emits a reference illumination energy HB1 under reference printing conditions in a reference printing event characterized by the reference printing conditions. The light encoding value LCW=2 or, respectively, LCW=3 leads to reference illumination energies HB2 or, respectively, HB3 in the reference printing event.

5   The light encoding data 20 are processed in a conversion and correction unit 24 that is explained in greater detail below with reference to Figure 3. Before printing begins, three correction factors K1, K2 and K3 have been determined in the conversion and correction unit 24. For example, the correction factors K1, K2 and K3 are automatically determined after every activation of the printer and/or after a

10   longer print [sie] job or, respectively, after a longer printing operation. The method steps that are thereby implemented are explained in greater detail below on the basis of Figure 2. A light encoding signal 26 is determined in the conversion and correction unit 24 dependent on the light encoding value of the light encoding data. Given the light encoding value LCW=0, a light encoding signal is generated that

15   leads to no illumination by the appertaining LED. Given the light encoding value LCW=1, a light encoding signal 26 is generated that -- taking the correction factor K1 into consideration -- effects an illumination with a corrected illumination energy HK1. Given the light encoding value LCW=2 or, respectively, LCW=3, a light encoding signal 26 is generated that -- taking the correction factor K2 or,

20   respectively, K3 into consideration -- leads to an illumination with a corrected illumination energy HK2 or, respectively, HK3.

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The light encoding signals 26 are employed for the drive of the character

generator 22. The character generator 22 contains a drive circuit for the LEDs of an

LED line (not shown) wherein neighboring LEDs have a spacing of approximately 42

μm from one another. Macro-cells are respectively generated by three LEDs

5   arranged sequentially when illuminating three successive lines. Light energy

distributions 28 emitted by the LEDs of a macro-cell partially superimpose. Given a

suitable selection of the light encoding values, light distribution ~~hills~~ **slopes** of

different light intensity that lead to a distribution 32 of potential on a photoconductor

30 similar to the respective light distribution arise within a raster cell. What is

10   achieved by defining a threshold of potential in a developing unit 34 is that toner

regions 36 with different diameters determined by the respective potential

distribution form in the macro-cells. A half-tone image is thus generated in a simple

way by employing the light encoding values. This methods are set forth in detail in

US ~~Letters~~ Patent **No.** 5,767,888, which is a constituent part of the disclosure of the

15   present application **and incorporated herein by reference**.

Figure 2 shows a potential/illumination energy diagram on whose abscissa

axis 50 the illumination energy is ~~eroded [sic]~~ **shown** in μWs/cm^2 and on whose

ordinate axis 52 the photoconductor potential is ~~eroded [sic]~~ **shown** in volts. Before

the beginning of the illumination, the photoconductor is respectively charged to a

20   charge potential VC of 500 V. A reference characteristic KLB shows the relationship

of potential on the photoconductor and illumination energy for a reference

photoconductor that is employed in the reference printing event. A characteristic

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KL1 of a photoconductor employed for printing at the moment deviates from the reference characteristic KLB. The deviations of the characteristics KLB and KL1 are to be attributed, for example, to the temperature or to the age of the photoconductor. Deviations of the characteristics KLB and KL1, however, also arise given a change

5   of the photoconductor or, respectively, when comparing the photoconductors of two different printer devices 10. In this case, manufacture-conditioned fluctuations as well as the quality of the photoconductors have an additional influence on the deviation of the characteristics KLB and KL1.

A further characteristic KL2 shows the dependency of the potential on a third

10   photoconductor on the illumination energy. Qualitatively, the characteristics KLB, KL1 and KL2 have a similar curve, so that only the curve of the characteristic KLB shall be explained below. With increasing illumination energy, the values of potential on the photoconductor drop according to a descending exponential function until a lowest obtainable discharge potential V_{LIM} is finally reached,

15   illustrated with a broken line 54.

The printing event leads to print images with high print quality when the potentials that are generated upon occurrence of the various light encoding values LCW = 0, 1, 2 or, respectively, 3 have an approximately uniform spacing from one another and are distributed over the entire discharge region that is available.

20   However, only potentials in the upper region of the discharge curve are taken into consideration in the following explanation in order to simplify the explanations. For example, the potential V1 should be generated given the light encoding value

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LCW=1. A potential V2 or, respectively, V3 should be generated given the light

encoding value 2 or, respectively, 3. The potentials V1 through V3 and the

reference characteristic KLB define the reference illumination energies HB1 through

HB3.

5   The determination of the correction factors K1 through K3 ensues in the

same way and is explained below on the basis of a correction factor K7. A potential

V7 should be generated on the photoconductor given a light encoding value LCW=7.

Given employment of a photoconductor with the reference characteristic KLB, this

requires a reference illumination HB7. Given employment of a photoconductor with

10   the characteristic KL1, a corrected illumination energy HK7 can be determined for

the potential V7 from the characteristic KL1. When the reference illumination energy

HB7 is divided by the corrected illumination energy HK7, then a correction factor K7

having a value of approximately 0.6 derives.

In the conversion and correction unit 24, the correction factor K7 leads

15   ~~thereto that~~ **to generation of** a light encoding signal for the corrected illumination

energy HK7 ~~is generated~~ instead of a light encoding signal for the reference

illumination energy HB7. Even given a photoconductor having a modified

characteristic KL1 compared to the characteristic KLB, the potential V7 is thus

generated given the light encoding value 7. The illumination process and, thus, the

20   entire printing process as well are not influenced by the variation of the characteristic

of the photoconductor.

Correction factors K1' through K9' derive for the characteristic KL2 in a similar

way. The correction factors K1' through K9', however, have values greater than 1.

Figure 3 shows the conversion and correction unit 24, which contains a

memory 56. A microprocessor (not shown) μP reads light level values from an

5   appertaining memory cell dependent on the light encoding value to be respectively

processed. In the exemplary embodiment being explained, there are 32 light levels

0 through 32 [sic] 31 with which the character generator 22 can be driven for the four

light encoding values 0 through 3. Without correction factors K1 through K3, the

light level value 0 belongs to the light encoding value 0, the light level value 10

10   belongs to the light encoding value 1, the light level value 20 belongs to the light

encoding value 2, and a light level value 30 belongs to the light encoding value 3. A

light level value 12 that is stored in the memory 56 derives after multiplication of the

correction factor K1 by the light level value 10 originally belonging to the light

encoding value 1. By multiplication with the correction factor K2, the light level value

15   20 becomes the light level value 21. The light encoding value 3 becomes the light

level value 31 by multiplication with the correction factor K3. When printing, the

conversion and correction unit 24 then allocates the light level values 0, 12, 21 or,

respectively, 31 to the light encoding values 0, 1, 2 or, respectively, 3. Modified light

encoding signals 26 that lead to the emission of modified illumination energies

20   thereby derive in the character generator 22.

Figure 4 shows equations (1), (2) and (3) that are employed in the

determination of the corrected illumination energies HK1, HK2 and HK3. The

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equations (1), (2) and (3) are explained below, likewise with reference to Figure 2.

Equation (1) reads:

$$V_D(K,T,H) = (V_C - V_{LIM}) \cdot exp(-K \cdot T \cdot H) + V_{LIM}, \tag{1}$$

whereby

V_C is the charge potential of the photoconductor in volts,

V_D is the discharge potential of the photoconductor in volts,

V_{LIM} is the lowest obtainable discharge potential in volts,

H   is the illumination energy in $\mu Ws/cm^2$,

T   is the currently acquired temperature of the photoconductor in °C,

K   is the photoconductor class in $cm^2 / (\mu Ws\,°C)$, and

exp   is the exponential function.

Equation (1) is an approximation for the respective characteristic of the photoconductor. The characteristics KLB, KL1 and KL2 in Figure 2 differ from one another on the basis of the photoconductor class K. Equation (2) arises by reformulating Equation (1) according to the photoconductor class K:

$$K(VD,T,H) = \frac{1}{T \cdot H} \ell n\left(\frac{VC - VLIM}{VD - VLIM}\right), \tag{2}$$

whereby

ℓn is the logarithm function.

When a standard illumination energy HS is prescribed for the illumination energy H and, following illumination of the photoconductor with this illumination

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energy HS, the arising discharge potential V_D as well as the temperature T of the photoconductor are acquired, then all quantities on the right side of Equation (2) are known and the photoconductor class K can be calculated. Alternatively, tables can be employed wherein photoconductor classes K calculated once for specific values

5   of V_D, T and H are stored.

When Equation (1) is reformulated according to the illumination energy H, then Equation (3) derives:

$$\mathbf{H(VD, K, T)} = \frac{1}{\mathbf{T \cdot K}} \ell \mathbf{n}\left(\frac{\mathbf{VC - VLIM}}{\mathbf{VD - VLIM}}\right), \qquad (3).$$

After the photoconductor class K has been determined, the corrected

10   illumination energies HK1, HK2 and HK3 can be determined from Equation (3) in that the potentials V1, V2 and V3 are successively inserted for the discharge potential VD. Subsequently, the correction factors K1 through K3 are determined by division. Prepared tables can thereby also be employed in order to implement the determination of the corrected illumination energies HK1, HK2 and HK3 fast.

15   Figure 5 shows a further potential/illumination energy diagram on whose abscissa axis 60 the illumination energy is ~~eroded [sic]~~ **shown** in $\mu Ws/cm^2$ and on whose ordinate axis 62 the photoconductor potential is ~~eroded [sic]~~ **shown** in volts. The reference characteristic KLB is modified to a reference characteristic KLB' by the prescription of an operator. For example, let the operator modify or,

20   respectively, correct the standard inkings of the macro-cells that derive given

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employment of the reference characteristic KLB. The width of fine written

characters, lines and dots is to ensue deviating from the width in a standard inking.

According to the prescription of the operator, the charge potential V_c of 500 volts is

boosted to a charge potential VC1 of 600 V. Instead of the potentials V1, V2 and

5   V3, potentials V1', V2' and V3' are prescribed. The determination of the current

characteristic KL1' of the photoconductor ensues as described above with reference

to Figure 2. Subsequently, the corrected illumination energies HK1', HK2' and HK3'

are determined, likewise according to the above-explained method. The potentials

V1', V2' and V3' are shifted toward higher potentials compared to the potentials V1,

10   V2 and V3. Given a development of the discharged photoconductor areas (DAD

--discharge area development), this means that the planes of section of the potential

troughs are constricted with the development threshold. Finer print elements or,

respectively, toner areas 36 arise. Given raster areas, this means that the raster

tonal value decreases and, thus, the raster areas become lighter. When, in contrast

15   thereto, the charged photoconductor areas are developed (CAD -- charged area

development), then broader print elements arise. The respectively opposite effects

arise given a reduction of the charge potential VC.

In another exemplary embodiment, the inking properties are regulated via the

development threshold in addition to the charge potential VC, in that an auxiliary

20   voltage V_{Bias} of the developer station is set to various values. An increase of the

auxiliary voltage V_{Bias} of the developer station yields broader print elements given

DAD and finer print elements given CAD. When the auxiliary voltage V_{Bias} is

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lowered, respectively opposite effects arise. The variation of the auxiliary voltage V_{Bias} effects a variation of the development characteristics that indicates [sic] the relationship of **the** photoconductor potential and toner deposit.

As in the exemplary embodiments explained above on the basis of Figures 1 through 5, only the upper section of the photoconductor characteristic is employed in fast printing processes because the illumination energies to be generated by the character generator are lower in this section and can be beamed out in shorter times. The photoconductor can therefore be moved past the LEDs of the character generator faster. The auxiliary potential V_{Bias} in the developer station must then lie clearly above the lowest photoconductor potential V_{LIM}.

Figure 6 shows a four-quadrant diagram with characteristics 100, 102, 102a, 104, 106 and 106a of the printing event. The upper left quadrant I shows a development characteristic 100 that indicates the relationship of the potential on the photoconductor and the toner deposit after the developing. The potential U of the photoconductor is therefore eroded [sic] **shown** on the abscissa axis 110 of quadrant I. The optical density D is eroded [sic] **shown** on the ordinate axis 112 of the quadrant I, this being a measure of the toner deposit. Given increase or, respectively, decrease of the toner concentration in a two-component toner, the discharge characteristic 100 shifts in the direction of a double arrow 101 toward the left or, respectively, toward the right. A constant toner concentration shall be assumed below, **to which** the development characteristic 100 belonging thereto **belongs**.

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The lower left quadrant IV shows a solid-line discharge characteristic 102 that indicates the relationship of illumination energy H and potential H $\underline{U}$ on the photoconductor. The illumination energy $\underline{H}$ is ~~eroded [sic]~~ **shown** on the ordinate axis 116 of the quadrant IV. The potential U is indicated on the abscissa axis 110 of the quadrant IV. The discharge characteristic 102 belongs to a photoconductor with the temperature 20°C. The curve of the discharge characteristic 102 essentially corresponds to the curve of the characteristic KLB explained on the basis of Figure 2. A discharge characteristic 102a shown with broken lines belongs to the photoconductor given a temperature of 40°C. The discharge characteristic 102a is likewise shown in quadrant IV.

A print characteristic 104 that indicates a predetermined relationship of light encoding values LCW and optical density D or, respectively, toner deposit on the photoconductor is shown in the upper right quadrant II. The optical density D is indicated on the ordinate axis 112 of the quadrant II. The light encoding values LCW are ~~eroded [sic]~~ **shown** on an abscissa axis 114 of the quadrant II. The relationship prescribed by the print characteristic 104 is preferably linear, so that the optical density D likewise increases when the light encoding value LCW increases. However, the print characteristic 104 can also have a different predetermined curve in order to create additional degrees of freedom for the printing process.

Proceeding from the print characteristic 104, the corrected illumination energies HK can be determined with the assistance of the relationships indicated in the four-quadrant diagram. The determination of the corrected illumination energies

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HK shall be explained below with the assistance of a graphic construct. This construct, however, is automatically implemented in the printer device by a microprocessor that processes the commands of a program that are stored in a memory of the printer device and with which the corrected illumination energies HK can be calculated.

For example, the corrected illumination energy value HK9 for the light encoding value LCW=9 is determined proceeding from the value defined by the print characteristic 104 for the optical density D given the light encoding value LCW=9. With the assistance of the development characteristic 100 illustrated in quadrant I, a voltage U is determined from this value of the optical density D, see arrows 120 and 122. With the assistance of the value of potential U determined from the development characteristic 100, an illumination energy HK that is employed as corrected illumination energy HK9 for the light encoding value LCW=9 is read off from the discharge characteristic 102, see arrow 124.

The illumination energies H belonging to the light encoding values LCW are shown in quadrant III. Thus, the corrected illumination energy HK9 of approximately 0.6 μWs/cm^2 belongs to the light encoding value LCW=9. A point P1 thus derives for the light encoding value LCW=9 given the illumination energy HK9=0.6 μWs/cm^2.

When the corrected illumination energies HK for the other light encoding values LCW are determined in the same way with the assistance of the four-quadrant diagram, then an encoding characteristic 106 derives in quadrant III

25

that indicates the relationship of light encoding values LCW and corrected

illumination energies HK. The point P1 lies on the encoding characteristic 106.

When a photoconductor with the discharge characteristic 102a is employed in

the printing event, the predetermined curve of the print characteristic 104 can

5 nonetheless be achieved when the corrected illumination energies are

re-determined. This is again explained with reference to the example of the light

encoding value LCW=9. Proceeding from the print characteristic 104, the value of

the optical density D belonging to the light encoding value LCW=9 is determined.

This value lies at approximately 1.8, see arrow 120. Subsequently, the appertaining

10 potential U is read from the development characteristic 100 for this value of the

optical density D=1.8, see arrow 122. This potential amounts to about 65 V, see

arrow 122. Subsequently, the illumination energy H is read from the characteristic

102a for the potential U=65 V determined in this way. A corrected illumination

energy HK9 of about 0.3 μWs/cm^2 derives. When the corrected illumination energy

15 HK9 determined in this way is entered in the quadrant III at a point P2, then one has

the first point of the characteristic 106a, which indicates the relationship between

light encoding values LCW and corrected illumination energies HK for the

photoconductor with the characteristic 102a. In a similar way, the corrected

illumination energies HK are determined for the other light encoding values LCW.

20 The relationship between light encoding values LCW and corrected illumination

energies HK illustrated with the encoding characteristic 106a derives.

26

In another exemplary embodiment, the development characteristic 100 is modified for achieving the print characteristic 104 in that the toner concentration is raised or, respectively, lowered. New degrees of freedom derive as a result thereof, these being particularly employed when the free selection of the corrected

5   illumination energy values HK is limited.

In addition to the print characteristic 104 shown in Figure 6, there is also a printing process characteristic (not shown) that indicates the relationship between illumination energy H and optical density D. Whereas the printing process characteristic is already fixed when the development characteristic 100 and the

10   discharge characteristic 102 are defined, the print characteristic 104 can still be varied. For example, a curve is prescribed for the print characteristic 104 as explained above. The print characteristic 104 is thus designationally modified.

~~List of Reference Characters~~ **Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventor**

15   **to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.**

10 printer device **Abstract of the Disclosure**

12 interface

14 print data

16 print data unit

MP microprocessor

18 memory

20 light encoding data

22 **A method for operating an electrophotographic printing device provides a multilevel** character generator **in the printer. Correction parameters are determined for the** LED light-emitting diode

0-3 light encoding values **such that a high-quality printed image is obtained, even if printing conditions are modified.** HB1-HB3 reference illumination energy

24 conversion and correction unit

K1-K3 correction factor

HK1-HK3 corrected illumination energy

26 light encoding signal

28 light energy distribution

30 photoconductor

32 values of potential

34 development unit

36 toner regions

50 abscissa axis, illumination energy

5

10

15

20

52 ordinate axis, photoconductor potential

KLB reference characteristic

25   KL1,KL2 characteristic of the photoconductor

KLB' lowest obtainable discharge potential

54 broken line

V1-V3 potential

V7 potential

30   HB7 reference illumination energy

HK7 corrected illumination energy

K7 correction factor

56 memory

H illumination energy

35   T temperature of the photoconductor

K photoconductor class

HS standardized illumination energy

60 abscissa axis, illumination energy

62 ordinate axis, potential

40   VC,VC1 charge potential

V1'-V3' predetermined potential

DAD discharged area development

CAD charged are development

VBias auxiliary potential of the development device

29

45   100 development characteristic

        101 double arrow

        102,102a discharge characteristic

        104 printing process characteristic

        106,106a encoding characteristic

50   I-IV quadrant

        110,114 abscissa

        112,116 ordinate

        P1,P2 point

        D optical density

55   LCW light encoding values

        120-126 arrow

        U potential